Space Weather Technical Forecast

Issued on Thursday, 16 May 2024 at 12:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Current CME influence likely declining near term. Slight chance of further X-class flares, mainly from a new region on the east limb. S1 Minor Solar Radiation Storm easing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with an X2.9 flare observed peaking at 15/1438 UTC, from the southeast limb, associated with some portion of the new observed region rounding the southeast limb. Any further activity from AR3664 is now likely to be completely obscured as it has retreated onto the far-side around the southwest limb. There are thirteen sunspots on the disc, eleven of which are numbered. The main flare risk is now likely from the new region on the southeast limb, with further associated strong spots likely to rotate onto the visible disc during the next 12-24 hours. This may be comprised of one large region, or a closely connected collection of different regions, however this is currently too close to the limb to accurately analyse. The other sunspot regions are generally smaller, simpler and stable, although the largest region AR3679 has shown some weak emergence within its intermediate spots.

No Earth-directed CMEs were identified in available imagery. A filament eruption was observed around 15/0950 UTC from the northeast disc, however this has been assessed as likely missing Earth, passing north and behind.

Solar Wind / Geomagnetic Activity: A weak CME glance likely arrived at L1 at 15/1814 UTC, potentially from the M6.6 flare of AR3664 on 13 May. No notable speed change was observed by ACE, with slightly elevated winds easing through much of the period to around 430km/s. However density rose from below average to around average values or just above. A second stronger CME arrival observed from 16/0430 UTC onwards, this from an uncertain source, with solar winds increasing slightly to 460-500km/s. Interplanetary Magnetic Field (IMF), Bt, was initially weak, below 5nT, but exhibited a small increase to 7-8 nT following the first CME glance and a further erratic increase to peak at 17nT following the second arrival, with values subsequently falling to around 3-4nT by the end of the period. The north-south component Bz weakly negative for much of the period, became more strongly negative following the second CME arrival, peaking at -13nT. Phi angle was predominantly positive (away from the Sun), but became erratic by the end of the period. Geomagnetic activity was Quiet to Unsettled (Kp1-3), but with a G2 Moderate geomagnetic storm interval recorded 16/0600-0900 UTC following the second CME arrival, and a G1 Minor geomagnetic storm interval 16/0900-1200UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) by GOES-18 has been at S1 Minor Radiation Storm level throughout. Observed proton flux has seen only a slight and erratic decline. High energy electron flux (greater than 2MeV) observed by GOES16 was Moderate to High, peaking at 1500 pfu at 15/1840 UTC before dropping to background, initially due to due to potential glancing CME arrival at 15/1814 UTC followed by a more significant drop following CME arrival beginning 16/0430 UTC. The associated 24-hour fluence in below the Active threshold on a falling trend, with an observed fluence at 16/0000

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UTC of 6.3e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is now expected, with a slight chance of further X-class flares. These mainly from the new region rotating onto the southeast limb which produced the X2.9 on 15 May. The regions currently on the visible disc are smaller and simpler, with isolated M-flares possible from these.

Solar Wind / Geomagnetic Activity: There is one CME currently in the forecast that may bring glancing influences, from a filament eruption on the north-east disc on 14 May. This is forecast to arrive later day 2 (17 May), but with low confidence. Otherwise solar winds are currently seeing continued CME influence from an uncertain source. This influence is expected to decline through day 1 (16 May) with winds expected to gradually ease towards background through the remainder of the period in the absence of further CME enhancement. Activity is expected to be mainly Quiet with Unsettled, but with spells of Unsettled to Active conditions likely both initially and from any further CME glances, with a slight chance of G1 Minor storm intervals.

Energetic Particles / Solar Radiation: GOES-18 proton flux is expected to continue slowly easing, likely falling below the S1 level during days 1-2 (16-17 May), but still with the potential for enhancements from any further significant flares from AR3664, as the protons can still be directed towards Earth along the Parker Spiral. This potential gradually declining as the sunspot moves further onto the far-side. High energy electron flux reduced to background following CME arrival but forecast to rise once again into the period as CME influences eases, bringing a chance of Active fluence by days 3 and 4 (18-19 May), however this is low confidence.

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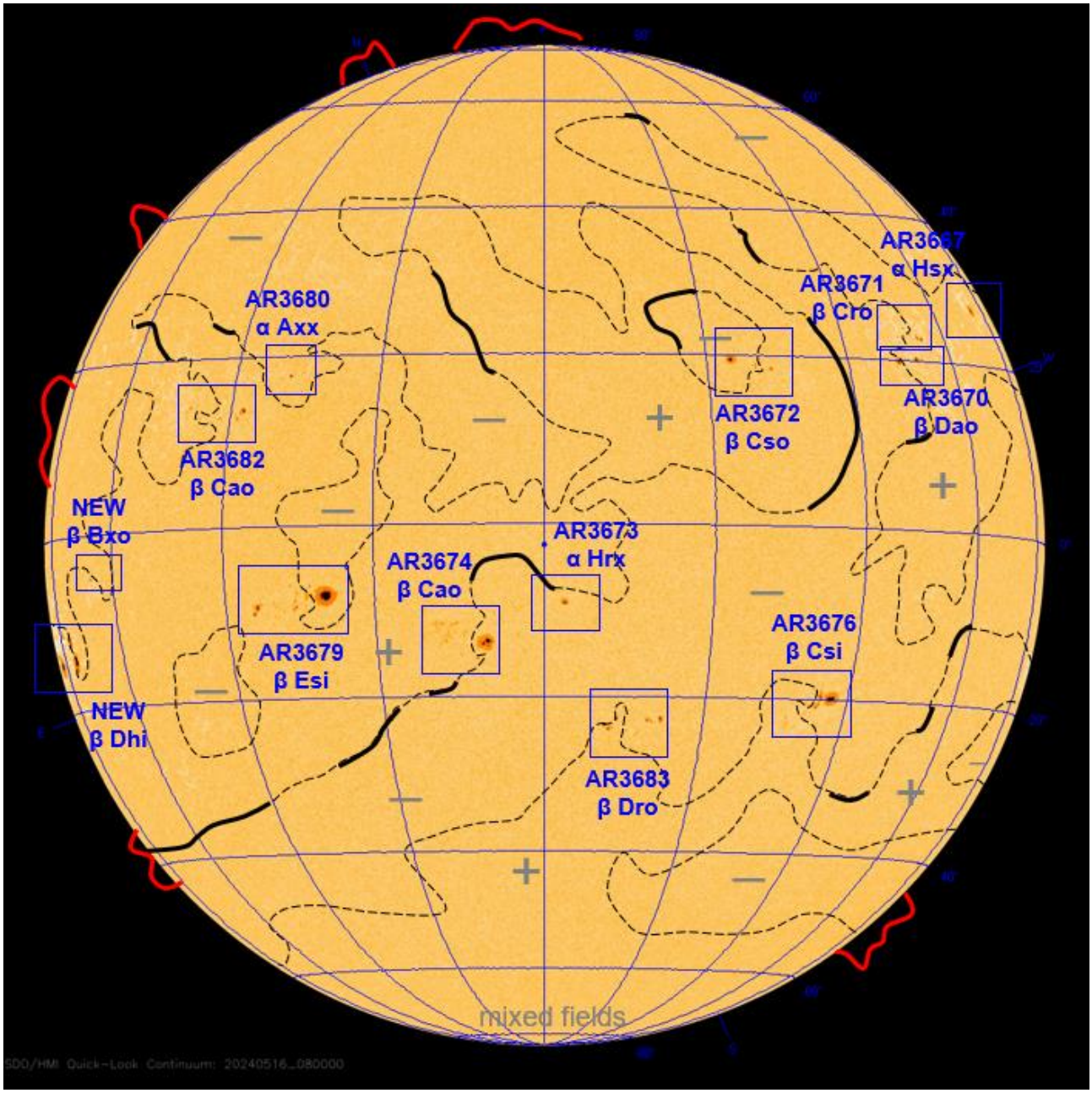
Figure 1. Solar Analysis Valid 16/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CMEs from AR3664 have now passed with any further CMEs from this region expected to miss the Earth. However there is one other CME potentially arriving at Earth. This is was due to a filament eruption from the northeast disc on 14 May. While largely passing north and behind Earth, glancing interactions are possible later on day 2 (17 May).

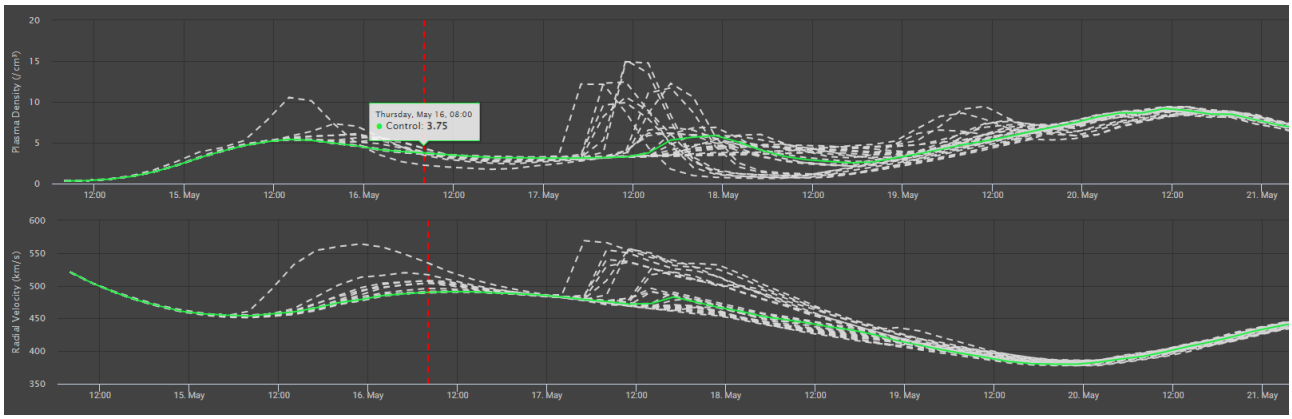
Otherwise solar winds are currently seeing continued CME influence from an uncertain source. This influence is expected to decline through day 1 (16 May) with winds expected to gradually ease towards background through the remainder of the period in the absence of further CME enhancement, with currently no notable coronal holes expected. Activity is expected to be mainly Quiet with Unsettled, but with spells of Unsettled to Active conditions likely both initially and from any further CME glances, with a slight chance of G1 Minor storm intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1526	Partial	Filament	NE	685 km/s	17/1800 UTC +/- 10hrs	Low confidence glancing impact

Figure 2: Latest MOSWOC ENLIL Ensemble output



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Radio Blackouts - X-Ray Flares:
Low to Moderate activity is expected, but with a chance of further High activity, this largely dependent upon a new region rotating onto the southeast disc. This was the source of an X2.9 flare on 15 May, but is currently difficult to analyse, with a fuller understanding of the flare risk likely through the coming 24 hours as this region continues rotating onto the visible disc. Recent activity has been dominated by the very active region AR3664, however this sunspot group has now moved onto the far-side with any subsequent activity increasingly unlikely to be visible from the Earth-side.

There are currently thirteen visible regions on the disc, however these are generally small and relatively simple groups that are unlikely to produce more than isolated M-flares. The largest of these is AR3679 in the southwest disc, and this has shown some slow growth, but remains a simple bipolar group.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	Yes	20	20	20	20

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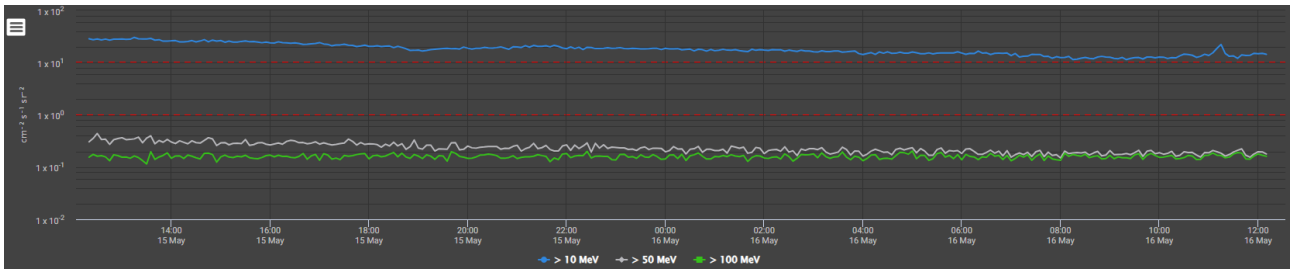
Solar Radiation Storms - (High Energy Protons):
S1 Minor Radiation Storm conditions persist at the start of the period. This was due to the M6.6 flare of AR3664 on the southwest limb on 13 May with some contribution also possible from the flaring from this region through 14-15 May, with at least four X-flares occurring.

Proton flux is expected to gradually ease, likely falling below minor storm levels through days 1-2 (16-17 May), although further enhancements cannot be ruled out if any large flares occur from AR3664 from over the southwest limb, as it remains possible that any subsequent protons can be directed towards Earth through the Parker Spiral. While there are a number of small sunspot regions of the Earth-facing disc none of these are currently considered candidates for proton rich flares, with the potential for proton storms decreasing as AR3664 moves further onto the far-side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	90	50	20	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: Latest 24hr GOES18 Proton Flux trace



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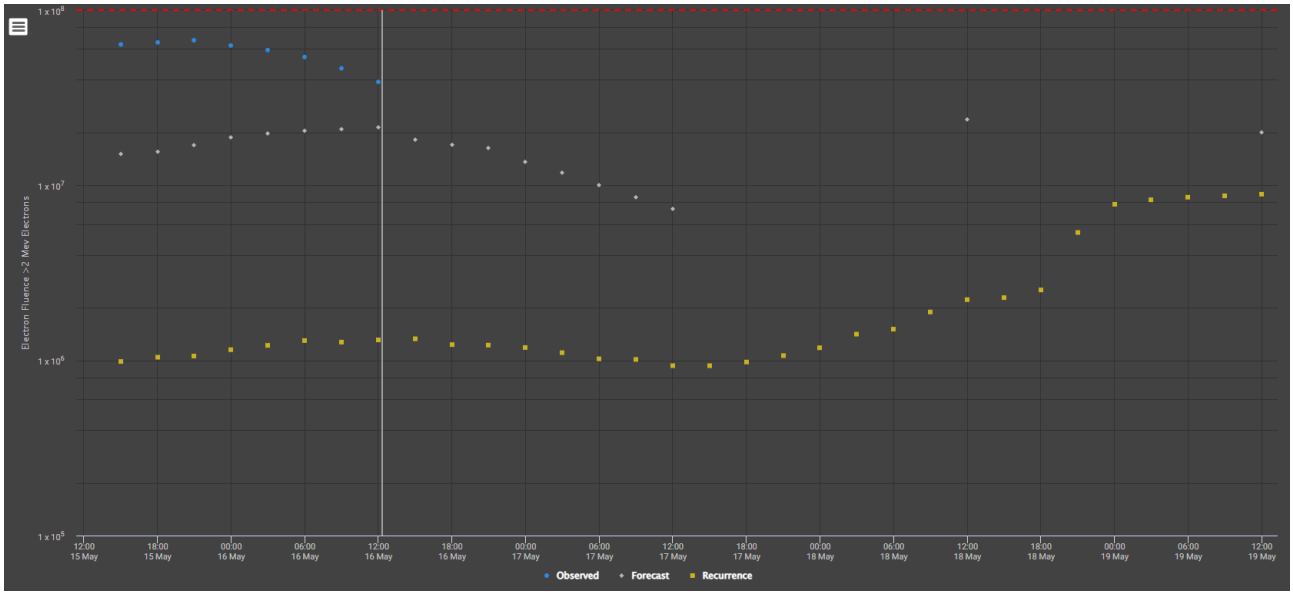
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16 has been at mainly Moderate to High levels, but has fell to background levels following the recent CME arrival. This trend is most likely to persist in the short term, however the potential for electron flux to continue to rise and potentially reach persistently High levels remains, with lower orbits having been highly charged by the CME arrivals over previous days. A continued rise in flux levels from day 2 (17 May) onwards is expected although confidence is further reduced due to another potential glancing CME later on day 2 or day 3 (17-18 May), with may again reduce the observed flux.

The associated 24 hour fluence is expected to see a general falling trend near term, before likely retuning to a rising trend later day 2 (17 May) onwards, perhaps approaching the Active threshold by days 3 and 4 (18-19 May). MOSWOC REFM providing reasonable guidance in the near term although perhaps under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	20	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output



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